USE OF WAIST HEIGHT RATIO IN IDENTIFYING CARDIOVASCULAR RISK FACTORS

Dissertation submitted for

MD Degree (Branch I) General Medicine

March 2009

The Tamilnadu Dr.M.G.R. Medical University
Chennai – 600 032.

MADURAI MEDICAL COLLEGE, MADURAI.

CERTIFICATE

This is to certify that this dissertation titled **"USE OF WAIST HEIGHT RATIO IN IDENTIFYING CARDIOVASCULAR RISK FACTORS "** submitted by **Dr. T.Ganesh** to the faculty of General Medicine, The Tamilnadu Dr. M.G.R. Medical University, Chennai in partial fulfillment of the requirement for the award of MD degree Branch I (General Medicine) is a bonafide research work carried out by him under our direct supervision and guidance.

Dr.MOSES K. DANIEL,
Additional Professor,
Department of Medicine,
Madurai Medical college,
Madurai.

Dr.A.AYYAPPAN,
Professor and Head,
Department of Medicine,
Madurai MedicalCollege,
Madurai.

Place: Madurai.
Date:

DECLARATION

I , **Dr T.Ganesh**, solemnly declare that the dissertation titled **"USE OF WAIST HEIGHT RATIO IN IDENTIFYING CARDIOVASCULAR RISK FACTORS"** has been prepared by me.

This is submitted to **The Tamil Nadu Dr. M.G.R. Medical University, Chennai,** in partial fulfillment of the rules and regulations for the award of MD degree (branch I) General Medicine.

Place: Madurai

Date: **Dr. T.Ganesh**

ACKNOWLEDGEMENT

At the outset, I wish to thank our Dean **Dr. S.M.SIVAKUMAR, M.S.,** for permitting me to use the facilities of Madurai Medical College and Government Rajaji Hospital to conduct this study.

My beloved Head of the Department of Medicine, **PROF.A.AYYAPPAN, M.D.** has always guided me, by example and valuable words of advice and has always given me his moral support and encouragement throughout the conduct of the study and also during my post graduate course. I owe my sincere thanks to him.

I also owe my sincere thanks to my unit chief **Dr.Moses K Daniel. M.D.,** for his support and valuable suggestions.

My special thanks to my guide and coordinator **Dr.David Pradeep Kumar MD.** my Asst. Professor for his guidance and advice through out the study.

Knowledge and kindness abounds my beloved teachers, **Dr.M.Kamaraj M.D., Dr.S.Vadivelmurugan M.D., Dr.D.D.Venkatraman M.D., Dr.M. MUTHIAH, M.D.; Dr.V.T.Premkumar M.D., Dr. P.Thirumalaikolundusubramanian**

M.D., Dr.Nalini Ganesh M.D., Dr. P.Selvaraj M.D., I owe them a lot and sincerely thank them.

I offer my heartfelt thanks to my Assistant Professors **Dr.K.Senthil M.D,,Dr.Ganesh Babu M.D.,** for their constant encouragement, timely help and critical suggestions throughout the study and also for making my stay in the unit both informative and pleasurable.

My family and friends have stood by me during my times of need. Their help and support have been invaluable to this study.

My patients, who form the most integral part of the work, were always kind and cooperative. I cannot but pray for their speedy recovery and place this study as a tribute to them and to the numerous others likely affected.

CONTENTS

INTRODUCTION

INTRODUCTION

The Indian subcontinent is undergoing an epidemiological upheaval as non-communicable diseases are becoming major cause of mortality and morbidity. Already the Indian subcontinent contributes to 16-18% of global mortality due to cardiovascular disease. By the year 2020, India is projected to have the largest number of individual cardiovascular risk factors. The current data suggests that prevalence of metabolic syndrome is about 40% higher than 25% quoted for western population.

Rising incidence of diabetes mellitus, systemic hypertension and dyslipidemia, the well known risk factor for cardiovascular disease is the leading cause for increased incidence of cardiovascular diseases[1]. Till today, body mass index and waist circumference are the two popular parameters used to assess the cardiovascular risk factors. Though Asian people are not overtly obese, they are still at an increased risk of cardiovascular disease and this may be due to presence of visceral obesity, but the cut off value for waist circumference varies among sex,

ethnics and countries. So we are still in need of simple, cheap and effective anthropometric parameter to assess cardiovascular risk of our population. In our study, use of Waist/Height ratio parameter was assessed for identifying cardiovascular risk and to compare with other studies.

The average height of Asian is low, when compared to western countries. Height is an independent negative predictor of cardiovascular disease, so waist circumference, as a parameter of visceral obesity should be taken in context to height as waist/height ratio.

Waist/height ratio with cut-off >0.5 is the newer parameter under clinical trial expected to emerge in clinical practice in near future. In our study, effectiveness of waist/height ratio was studied in identifying cardio-metabolic risk factors. This parameter was also compared with well known other parameters like body mass index and waist circumference in our study.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Evolution of cardio-metabolic risk factors clustering as a 'syndrome'

The propensity of clustering of metabolic and cardiovascular risk factors in the same individual has been recognized for many years. The first description of cardio-metabolic risk factor clustering appeared in the medical literature in 1923,when Eskil Kylin (1889 – 1975), a Swedish physician, described a syndrome involving hypertension, hyperglycemia, and hyperuricemia. Sixty five years later in 1998, Reaven described a cluster of risk factors for diabetes and CARDIO VASCULAR DISEASE. (hypertension, hyperglycemia, glucose intolerance, elevated triglycerides and low HIGH DENSITY LIPOPROTEIN level). He named it as syndrome X and introduced the concept of insulin resistance[4].

In 1998 WHO proposed the term metabolic syndrome rather than insulin resistance syndrome, since insulin resistance alone could not explain all components of the syndrome. However use of the term 'metabolic syndrome' remained relatively uncommon until 2001 when the National cholesterol education program Adult treatment panel (NCEP ATP III) identified the metabolic syndrome as a risk factor for

CARDIOVASCULAR DISEASE and as a target for lipid – modifying and other CARDIO VASCULAR DISEASE risk reduction therapies.

Criteria proposed for clinical diagnosis of metabolic syndrome

Clinical measure	WHO (1998)	ATP III (2001)
Insulin resistance	IGT, IFG or lowered insulin sensitivity plus any two of the following	None, but any 3 of the following 5 features
Body weight	Men : WHR > 0.90 Women: WHR > 0.85 and / or BMI > 30kg/m^2	WC > 102 cm in men or > 88 cm in women
Lipid	TG > 150 mg/dL and / or HIGH DENSITY LIPOPROTEIN < 35mg/dL in men or < 39 mg/dL in women	TG > 150 mg/dL HIGH DENSITY LIPOPROTEIN <40mg/dL in men or <50mg/dL in women
Blood pressure	>140/90 mmHg	>130/85 mmHg
Glucose	IGT, IFG or T2DM	>110 mg/dL (includes diabetes)
Other	Microalbuminuria	Other features of insulin resistance

GENERALISED OBESITY

The majority of the patients with CORONARY ARTERY DISEASE are overweight and severity of the disease is more in them. Obesity markedly reduces the life span by about 22% (Kevin P et al). Obesity is associated with increased risk of hypertension, diabetes, dyslipidemia and CORONARY ARTERY DISEASE[26].

BMI (Body mass index) which is defined as the weight in kilogram divided by height in meter squares is now accepted as an important measure of obesity.

Classification of overweight and obesity by body mass index (Kg/m^2)

Underweight	< 18.5	
Normal	18.5 – 24.9	
Overweight	25 – 29.9	
Obesity		
Class I	-	30.0 – 34.9
Class II	-	35.0 – 39.9
Class III	-	>40(Extreme obesity)

(API Text Book)

The drawback of BMI is that, it does not convey information about the distribution of body fat. South Asians have increased abdominal visceral fat and greater insulin resistance at lower levels of BMI, which suggest that reliance on BMI alone may underestimate true risk in our population[27]. Now WHO has revised obesity cut off for Asians from BMI > 30 to BMI > 25.

Cut off points of BMI for Asian Indians (Hubbard et al)

Underweight	< 18.5	
Normal range	18.5 – 22.9	
Overweight	> 23	
At risk	-	23 – 24.9
Obese I	-	25 – 29.9
Obese II	-	> 30

Apple type and pear shaped obesity

On the basis of body fat distribution, obesity may be classified into android and gynoid types.

Android obesity is the collection of fat mostly in the abdomen (above the waist). It is also called central obesity

and is associated with an increased risk of metabolic complications such as CORONARY ARTERY DISEASE, DM, HT and dyslipidemia. It is the most common acquired cause of insulin resistance. Also known as apple type body[5].

Gynoid obesity (Pear shaped body) is the collection of fat on the hips and buttock (below the waist or gluteo-femoral). This makes the person more prone to mechanical disorders such as varicose veins and disorders of the joint.

BMI AND WEIGHT CUT POINT FOR OVERWEIGHT AND OBESITY AT DIFFERENT HEIGHTS IN ASIAN INDIANS

Adapted from NHLBI obesity Task Force, 199859 diabetes.com.au/research.obesity.htm .Feb 2006.

BMI	Optimum	Overweight	Obese 1	Obese 2
	20	23	25	30
Height in Cm	Weight in kg			
146	43	49	53	64
149	44	51	56	67
152	46	53	58	69
155	48	55	60	72
158	50	57	62	75
161	52	60	65	78
164	54	62	67	81
167	56	64	70	84
170	58	66	72	87
173	60	69	75	90
176	62	71	77	93
179	64	74	80	96
182	66	76	83	99
185	68	79	86	103
188	71	81	88	106
191	73	84	91	109
194	75	87	94	113
197	78	89	97	116
200	80	92	100	120

MEASURE OF ABDOMINAL OBESITY:

The abdominal or truncal obesity was measured by only few anthropometric indices.

They are

1. Waist circumference
2. Waist /Height ratio (Newer parameter)

As evidenced the abdominal obesity is a marker of insulin resistance. So anthropometrics used to measure abdominal obesity correlates with cardiovascular risk factors.

WAIST CIRCUMFERENCE:

Till now the most popular and effective anthropometric parameter used to assess abdominal obesity and cardio metabolic risks is waist circumference. Waist circumference was measured at the mid level between lower costal margin and Iliac crest. The cut off proposed for waist circumference by ATP – III criteria is

Males> 102 cms

Females > 88 cm

But for Asians the waist circumference is low when compared to western population.

In Asians, the cut off value used for waist circumference is

Males> 90 cms

Females > 80 cms.

In metabolic syndrome, waist circumference is the anthropometric parameter used to measure insulin resistance. In Asians the BMI is low when compared to western population but they are at increased risk of cardio vascular disease[5]. The pattern of obesity among Asians is abdominal obesity; Till now, waist circumference was the best parameter used in assessing conventional cardio vascular risk factors like,

1. Glucose intolerance
2. Hypertension
3. Dyslipidemia .

DRAW BACKS OF WAIST CIRCUMFERENCE:

1. There is no International standard cut off values for waist circumference.
2. Different cut off used for various ethnic groups.
3. Cut off values varies among both sexes.
4. Height,an independent negative risk factor for cardiovascular disease is not taken into account.

In Asians, as per evidence the average height is lower when compared to western population. With same waist circumference the cardio vascular risk of a individual varies for different height. As height increases, the cardio vascular risk decrease[2]. So we are still in need of a better parameter to identify cardio vascular risks.

WAIST / HEIGHT RATIO: (NEWER PARAMETER)

Waist / Height ratio was the new parameter under study to identify cardio vascular risk factors. Few studies are done among Japanese population to assess the effectiveness of Waist / Height ratio in identifying cardio vascular risk factors. This study was published in the Journal of Preventive Medicine in July 2004. Fewer similar studies are conducted among Japanese population[28].

The cut off used in the study for waist / height ratio is 0.5, above which it is abnormal. It means the waist circumference should be kept below half of the height of the individual. If the waist circumference is more than half of the height, the cardio vascular risk increases as per the study. In the study it was also found that waist / Height ratio was the superior parameter than BMI and waist circumference in identifying cardio vascular risk factors.

ADVANTAGES OF NEWER PARAMETER OVER OLDER ONES:

In waist / height ratio, the cut off values are the same for all ethnic groups, both sexes and for all ages. So the standard cut off > 0.5 was used in all population.

Height, an independent negative risk factor for cardio vascular disease is also taken into account; waist circumference is viewed in the context of height. So accurate assessment of cardio metabolic risk can be done using this parameter. It also helps in identifying the cardio vascular risk factors at an early stage compared to BMI and waist circumference. So it provides early options for therapeutic intervention to halt the progression of cardio vascular disease.

As per the results of the study done among Japanese population, this parameter has more sensitivity in identifying the cardio vascular risk factors. It also has close correlation with cluster of cardiovascular risk factors. In the study, it was found to be an effective and superior anthropometric parameter in identifying cardiovascular risk factors than BMI and waist circumference[29]. Indian and Western studies are not yet available on this parameter. But is expected to come in near future.

Since Waist / Height ratio is a cheaper and effective parameter as per study results conducted among Japanese population, this parameter may replace waist circumference in assessing cardio metabolic risks in near future.

DIABETES MELLITUS

Both Diabetes and impaired glucose tolerance are associated with increased cardiovascular risk. A recent study in India showed a prevalence of diabetes and IGT as 12.1% and 15% respectively.

Diabetes is associated with central obesity, hypertension, atherogenic dyslipidemia and insulin resistance, all of which have been associated with high CAD risk. Diabetic dyslipidemia consists of elevated triglyceride, low HDL, and an increased proportion of small dense LDL[6].

HYPERTENSION

Hypertension is a strong risk factor for CAD. It accelerates the atherosclerotic process especially if Hyperlipidemia is also present. Recent data shows that even high normal levels (SBP 130-139mm of Hg and DBP 85-89 mm of Hg) are associated with doubling of CAD risk. Hypertension is closely related with salt intake, alcoholism and obesity[7].

INSULIN RESISTANCE AND VISCERAL OBESITY:

Metabolic syndrome is a collection of risk factors that together increase the risk of cardiovascular morbidity and mortality. The central factor in metabolic syndrome is proved to be Insulin resistance.

Insulin Resistance can be primary (genetic) or secondary[8]. The central obesity; a quite essential feature of metabolic syndrome is strongly related to Insulin resistance and may contribute to its pathogenesis through an increase in visceral adipocytes[30].

INSULIN RESISTANCE AND TYPE 2 DM:

Visceral adipoctyes play an important role in the development of Type 2 Diabetes Mellitus[9].

(1) Lipid accumulation in Liver and muscles, leads to Insulin insensitivity in these areas and may lead to Type 2 DM.

(2) Lipid accumulation in Islets may lead to apoptosis of β cells and Type 2 DM.

INSULIN RESISTANCE AND SYSTEMIC HYPERTENSION:

Hyper Insulinemia in insulin resistance [10]may lead on to hypertension in various ways like

(1)Sodium and Water retention,

(2) Anti-natriuretric effect,

(3)Sympathetic Overactivity,

(4)Smooth muscle proliferation ,

(5)Vasoconstrictor effect.

INSULIN RESISTANCE AND DYSLIPIDEMIA:

Insulin Resistance also contributes to dyslipidaemia by various mechanisms. Insulin resistance at the level of adipose tissue causes increase in release of free fatty acids which was taken up by liver and results in increased VLDL particle secretion. These raised levels of VLDL circulation then exchange their TGL content for cholesterol esters from HDL and LDL. This triglyceride rich LDL is hydrolysed by Lipoprotein Lipase leading to formation of small dense LDL. Then the triglyceride rich HDL is a good substrate for hepatic lipase and releases some APoA from it, which is lost through kidneys leading to increased HDL clearance[11].

Thus Insulin resistance leads onto

(1) Hypertriglyceridemia,

(2)Low HDL levels ,

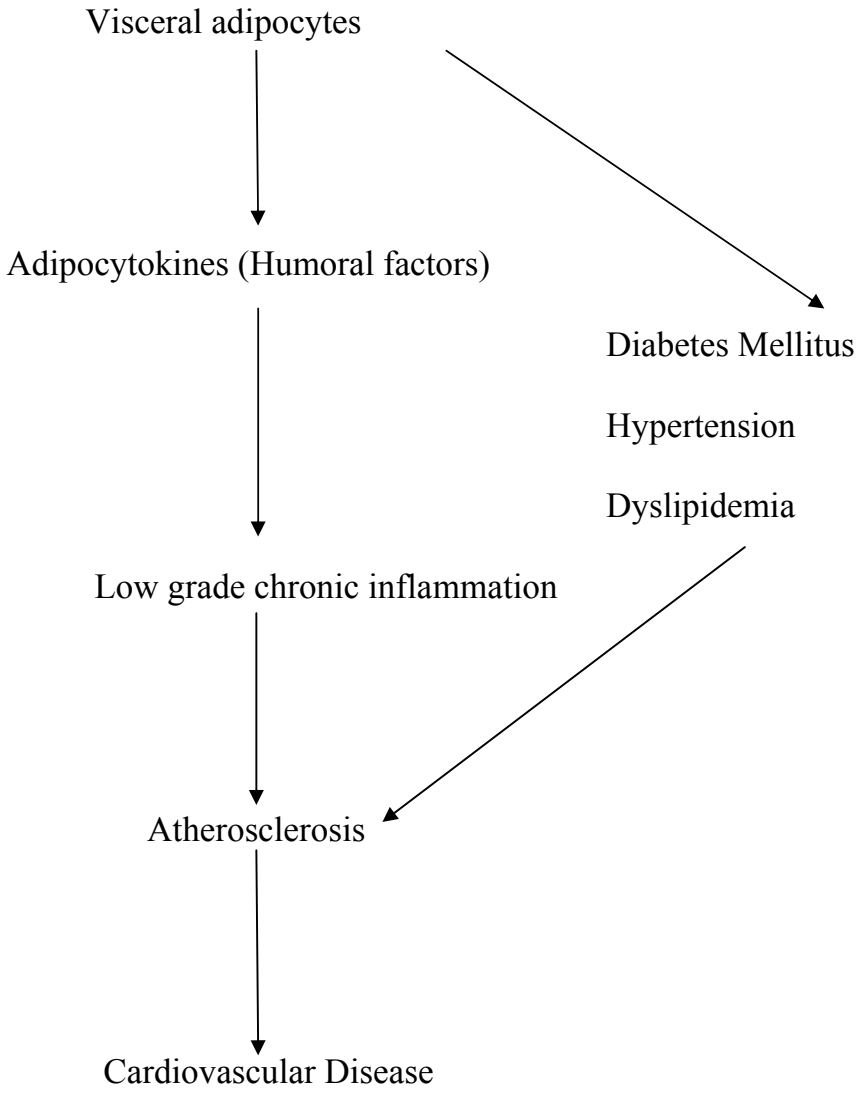
(3)Increased levels of small dense LDL.

INSULIN RESISTANCE AND ATHEROSCLEROSIS:

Visceral adipocytes increases the risk of atherogenesis in various ways by causing glucose Intolerance, hypertension and dyslipidaemia which are the important risk factors for atherosclerosis. Apart from these effects, visceral adipocytes aggregates atherosclerosis by secretion of various adipo cytokines and hormones.

The inflammatory substances produced by the visceral adipocytes are C-reactive protein, IL6, TNF-α, plasminogen activator inhibitor-1, resistin and adiponectin. Among these substances adiponectin plays a protective role against atherosclerosis.

Atherosclerosis is caused by low grade chronic inflammation, so these inflammatory adipocytokines play a dominant role in pathogenesis of atherosclerosis.



HUMORAL FACTORS IN CENTRAL OBESITY AND INSULIN RESISTANCE

Adipocytes are now known to secrete a wide range of products, some of which may impair insulin action through endocrine effects on distant target tissues and / or paracrine actions on neighbouring cells[12].

LEPTIN

Circulating leptin concentrations are proportional to total body fat mass, making it an attractive candidate as a mediator of insulin resistance in obesity . However, this notion remains controversial:

Some studies suggest that leptin interferes with insulin action in the liver, whereas others report inhibition of hepatic gluconeogenesis. Leptin has also been reported to inhibit insulin signalling in adipose tissue. Leptin has no obvious direct effect on insulin action in skeletal muscle, but it may activate central sympathetic nervous system activity, and this could induce insulin resistance. Paradoxically, in a mouse model of lipoatrophic diabetes, it was found that Leptin can partially improve insulin action. Recently Leptin replacement has been shown to reverse insulin resistance in human

subjects with lipoatrophic diabetes and low circulating leptin levels. Leptin mRNA concentrations are lower in visceral than subcutaneous fat, so it is possible that insulin-sensitizing effect is diminished in subjects with a high visceral fat mass.

TUMOUR NECROSIS FACTOR

This cytokine is produced in adipose tissue; its expression is increased in obesity, and early evidence suggested that it might interfere with insulin signaling directly, by inhibiting phosphorylation of the insulin receptor. Furthermore, TNF knockout mice are more insulin-sensitive than controls, and immunoneutralization with anti-TNF antibodies improves insulin sensitivity in rodents.

In humans, circulating TNF levels tend to correlate with adiposity and insulin sensitivity in some studies but the importance of circulating TNF as a mediator of obesity related insulin resistance has been questioned, because concentrations are low, immunoneutralization experiments do not affect insulin sensitivity and most circulating TNF is derived from sources other than a recent study indicated that insulin-

mediated glucose uptake was negatively correlated with TNF-alpha secretion from human adipocytes.

ADIPONECTIN

Adiponectin (also known as Acrp30 and Adios) is a recently described adiposity product that intriguingly appears to ameliorate insulin resistance in both muscle and liver. It is a 244-residue cytokine-like protein with some structural homology to TNF. In rodents, its expression and secretion fall with increasing fat mass, and adiponectin replenishment improves insulin resistance in various models of genetic and diet-induced obesity. Treatment with insulin-sensitizing PPAR-gamma agonists such as rosiglitazone increased adiponectin expression. Interestingly, treatment of lipoatrophic diabetes with adiponectin also improved insulin resistance and the effects were additive to those of leptin. It is therefore hypothesized that low levels of adiponectin might contribute to insulin resistance in obesity. The mechanism by which adiponectin might improve insulin resistance is yet to be clarified, but current evidence suggests that it increases fat oxidation in both muscle and liver tissue. In humans,

adiponectin levels are also decreased in obesity, and rise with weight loss[13]. The adiponectin gene is localized to human chromosome 3q27, a locus that has been associated with susceptibility to type 2 diabetes and the metabolic syndrome in genetic studies. Further more, adiponectin accumulates in vessel walls and inhibits TNF-induced cell adhesion, and thus also implicated in protection against endothelial dysfunction suggesting a wider role in the pathogenesis of the metabolic syndrome.

RESISTIN

Resistin (independently identified as Fizz3) is the product of an adipocyte-specific gene whose expression is down-regulated by the insulin-sensitizing thiazolidinediones. Subsequent work suggested that resistin was secreted by adipocytes, that dietary obese mice had high circulating resistin levels, and that administration of resistin antibodies ameliorated insulin resistance in these mice[14]. Resistin was named for its putative role in mediating insulin resistance in obesity.

Subsequent reports have some doubts over this hypothesis, as another PPAR gamma agonist, GW 1929, appears to up-regulate resistin gene expression; moreover, the human homologue of resistin is only expressed at very low levels in adipose tissue, and does not appear to be regulated by PPAR gamma agonist. Clarification of its role and possible impact on insulin signaling is awaited.

Peroxisome proliferator-activated receptor- gamma

This nuclear receptor is expressed principally in adipocytes and has been identified as the target for the thiazolidinedione class of insulin-sensitizing drugs. Dominant negative mutations are associated with severe insulin resistance. PPARG gene knockout models show increased insulin sensitivity, indicating that this gene has complex roles in regulating insulin sensitivity; this is not surprising, given its numerous effects on the differentiation of adipocytes and other cell types. The PPARG gene is also expressed in skeletal muscle, although at a lower level than in adipose tissue. PPAR gamma expression has been reported to be higher in skeletal muscle in obese subjects, but its expression is not altered in subjects with type 2 diabetes, independently of obesity[15].

Recently a common polymorphism (Pro 12Ala) in the PPARG been found to be associated with increased insulin sensitivity in humans, although whether this protects against the development of diabetes in humans remains to be seen.

Various cytokines and other factors, including PAI-1 and IL-6 also have been found to be produced in adipose tissue, and could play a role in insulin resistance. For example PAI-1 production is stimulated by insulin, and there is some evidence that increased levels may contribute to the prothrombotic state and IL-6 has been associated with insulin resistance in Pima Indians.

CORONARY ARTERY DISEASE

Coronary artery disease is the leading cause of death all over the world. CORONARY ARTERY DISEASE rate vary 10 fold among populations. CORONARY ARTERY DISEASE rates among overseas Asian Indians world wide are 50% to 400% higher than people of other ethnic origin irrespective of gender, religion and cast[16].

India is now in the middle of a CORONARY ARTERY DISEASE epidemic with urban Indians having CORONARY

ARTERY DISEASE rates which is 4 fold higher than Americans (Enas Enas et al).

Cardinal features of CORONARY ARTERY DISEASE among Asian Indians:

(1) Asian Indians are prone to develop CORONARY ARTERY DISEASE at a younger age, often before the age of 40 years in men.

(2)They are more likely to have an anterior location of infarction and are significantly younger at the time of firs hospitalisation for heart failure.

(3)CORONARY ARTERY DISEASE in Indians is known to be severe, extensive and malignant despite a lower age and a greater proportion of non smokers.

CORONARY ARTERY DISEASE mortality rates are 2 fold higher in Asian Indian women of 45-64 years of age than in whites[17].

Prevalence of CORONARY ARTERY DISEASE in India:

In India the number of deaths due to CORONARY ARTERY DISEASE was 1.7 million in 1990 and 1.59 million in 2000. It is projected to be 2.03 million by 2010.

The prevalence of CORONARY ARTERY DISEASE in urban India is double the rate than in rural India. The rates appear to be higher in south India with Kerala having a prevalence of 13% in urban areas and 7% in rural areas. CORONARY ARTERY DISEASE prevalence in New Delhi is 10% and in Chennai, it is 11% (2). These rates are similar to those among more affluent overseas Indians.

The excess burden of CORONARY ARTERY DISEASE in Asian Indians is due to a genetic susceptibility, mediated through elevated levels of lipoproteins which magnifies the adverse effects of lifestyle factors associated with urbanization, affluence and changes in diet. There is higher rate of abdominal adiposity among urban population, which results in significant dyslipidemia and insulin resistance and a 3 fold increase in diabetes. A more aggressive approach to

prevention and treatment of both conventional and emerging risk factors is warranted in Indians.

Risk factors for CORONARY ARTERY DISEASE

Risk factors for CORONARY ARTERY DISEASE can be broadly divided into modifiable and nonmodifiable. The modifiable one can be again divided into lipid and nonlipid factors.

Non modifiable risk factors

1. Age:

   Male > 45 years

   Female > 55 years

2. Family history of premature CORONARY ARTERY DISEASE –

   Male first degree relative < 55 years

   Female first degree relative < 65 years

3. Male Sex:

Modifiable – non lipid risk factors:

1. Hypertension
2. Diabetes

3. Smoking
4. Life style risk factors:

    Obesity – BMI > 30 kg/m^2

    Physical inactivity

    Atherogenic diet

Modifiable – Lipid risk factors:

1. Total cholesterol > 200 mg/dL
2. Trigylceride > 150 mg/dL
3. HIGH DENSITY LIPOPROTEIN < 40 mg/dL
4. LOW DENSITY LIPOPROTEIN > 100 mg/dL

Emerging risk factors

1. Impaired fasting glucose
2. Homocysteine > 15 µmol/L
3. Subclinical atherogenesis
4. Prothrombotic factors
5. Proinflammatory factors

JAMA 285, 2486 ; 2001

Coronary risk factors for Asian Indians

Fixed

Male age > 25 years

Female age > 45 years

Family history of premature CORONARY ARTERY DISEASE < 55years

Modifiable non lipid

Hypertension

Cigarette smoking / Tobacco Abuse

DM / Insulin resistance syndrome

Apple obesity or BMI > 22

Homocysteine > 10 μ mol /L

High PAI – 1

Modifiable lipid

TC > 150 mg / dL

TGL > 150 mg / dL

LOW DENSITY LIPOPROTEIN > 100 mg / dL

Apo b > 100 mg /dL

HIGH DENSITY LIPOPROTEIN < 40 mg / dL in male

< 50 mg / dL in females

Modifiable lipoprotein ratio

1. LOW DENSITY LIPOPROTEIN / HIGH DENSITY LIPOPROTEIN > 3.5
2. TC / HIGH DENSITY LIPOPROTEIN > 4.5
3. Apo a / Apo b < 1.2
4. Lipid Tetrad = Lp(a) x TG x LOW DENSITY LIPOPROTEIN / HIGH DENSITY LIPOPROTEIN > 20000 mg/dL

(API text book of medicine – 7th edition p – 433).

CORONARY ARTERY DISEASE risk factors can also be classified as conventional and emerging risk factors. Compared to other ethnic groups, Indians have a lower prevalence of Hypertension, hypercholesterolemia, obesity and smoking, but a higher prevalence of high triglycerides, low level of HIGH DENSITY LIPOPROTEIN, glucose intolerance and central obesity. Although the conventional risk factors do not fully explain the excess burden of CORONARY ARTERY DISEASE, these risk factors appears to be doubly important and remains the principal target for prevention and treatment.

AIMS AND OBJECTIVES

AIM OF THE STUDY

1. To assess the effectiveness of the newer anthropometric index, Waist/Height ratio in identifying Cardiovascular risk factors.

2. To compare the effectiveness of various anthropometric indices Body mass index, Waist Circumference and Waist/Height ratio in identifying Cardiovascular risk factors.

3. To prove the superiority of Waist/Height ratio over body mass index and waist Circumference in identifying Cardiovascular risk factors.

MATERIALS AND METHODS

MATERIALS AND METHODS

Selection of Subjects:

Among patients attending medical OP department in government rajaji hospital for various illness, 135 patients were included in our study

Males : 114

Females : 21

Period of the Study:

Patients were taken up during the period from January 2008 to October 2008.

Age Group:

Patients were selected between the age group of 20-75 Years, both males and females.

Exclusion Criteria:

135 patients were selected after excluding some patients because they produced falsely elevated anthropometric parameter, waist circumference and weight due to ascites and volume overload.

They were

Chronic renal failure

Cirrhosis of liver

Congestive cardiac failure

Nephrotic syndrome

Hypo thyroidism

Ascites of any cause.

History:

Careful history taking was first taken in these patients regarding pre existing diabetes mellitus, systemic hypertension and dyslipidemia and about the treatment for these illnesses.

Anthropometry:

In all these patients the following anthropometric measurements are done

(1)Height,

(2)Weight,

(3)Waist Circumference.

Height:

Height was taken by asking the patient to stand erect against the wall and vertical height was measured in centimeters.

Weight:

Weight was measured in kilograms using a weighing machine.

Waist Circumference:

Waist circumference was taken using an inch tape at the midlevel between lower costal margin and Iliac crest.

From these anthropometric measures, body mass index and Waist/Height ratio were calculated.

Body mass Index:

Calculated by the formula

$$\frac{\text{Weight in Kgs}}{[\text{ Height in cms}]^2}$$

Weight/Height ratio:

$$\frac{\text{Weight in Kgs}}{\text{Height in cms.}}$$

Blood pressure recording:

BP was taken 3 times over a period of 1 week to confirm Systemic Hypertension.

Investigations:

The following Investigations are done after a overnight fasting for >8 hours

(1)Fasting plasma Glucose,

(2)Serum Total Cholesterol,

(3)HDL,

(4)Triglyceride.

The information collected regarding all the selected cases were recorded in a master chart. Data analysis was done with the help of Computer using Epidemiological information package (EPI 2002).

Using this software, frequencies, percentages, means, standard deviations, chi -square and ‘P’ values were calculated. Kruskal wallis Chi – square test was used to test the significance of the difference between quantitative variables and test for qualitative Variables. A ‘P’ value less than 0.05 is taken to denote significant relationship.

RESULTS

RESULTS AND ANALYSIS

Profile of the study:

In our study ,135 patients was selected randomly. The cut off values of anthropometric indices which was taken as abnormal are

Body mass index > 25kg/m2

Waist Circumference Males > 90cms

Females> 85cms

Waist/Height ratio > 0.5

The cut off values for metabolic risk factors above which was taken as abnormal are

Fasting plasma Glucose ≥ 110mg/dl

Systemic Hypertension ≥ Sitting BP ≥ 140/90 mm Hg

Total Cholesterol ≥ 220mg/dl

HDL ≥ 40mg/dl

Serum Triglycerides ≥ 150mg/dl

The cut-off values used in this study for cardiovascular risk factors was the same used in WHO criteria for metabolic syndrome but the waist circumference cut off value in our study was taken from the values for Asian population. The cut-off value for waist/height ratio was taken as > 0.5 because this was the cut-off used in a previous similar study done among Japanese population.

(A)**Characteristics of Cases studied**

Table 1: Age Distribution

The following table categorises patients in our study according to the age.

Age group (in years)	Cases	
	No	%
Less than 30	4	3.0
30-39	17	12.6
40-49	35	25.9
50-59	44	32.6

60-69	29	21.5
70 & above	6	4.4
Total	135	100
Mean S.D.	50.7 years 11.6 years	

In our study patients were between the age group 20-75. The mean age group in our study was 50.7± 11.6 years. This mean age of patients in our study is the ideal age for our study, because the cardiometabolic risk factors appears to be high in this age group (**Figure 1).**

Figure 1

AGE DISTRIBUTION OF PATIENTS IN OUR STUDY

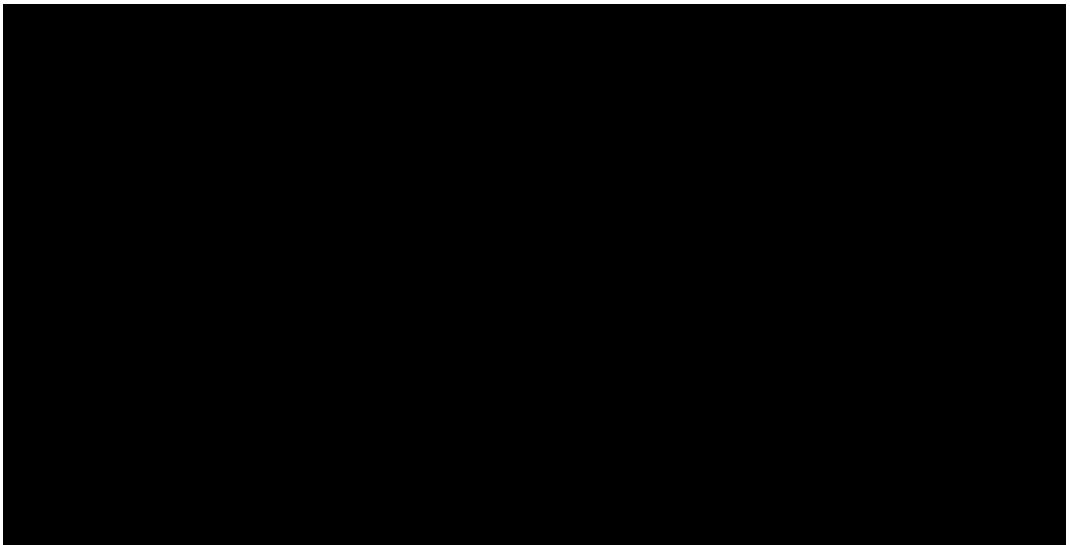


Table 2: Sex distribution

The following table shows sex distribution of patients in our study.

Sex	Cases	
	No	%
Males	108	80
Females	27	20

In our study group ,80% of patients were males. Females were less in our study because acceptance to take part in the study was less among

female sex. The reason for which most of the females were not willing to take part in the study was not known **(Figure 2)**.

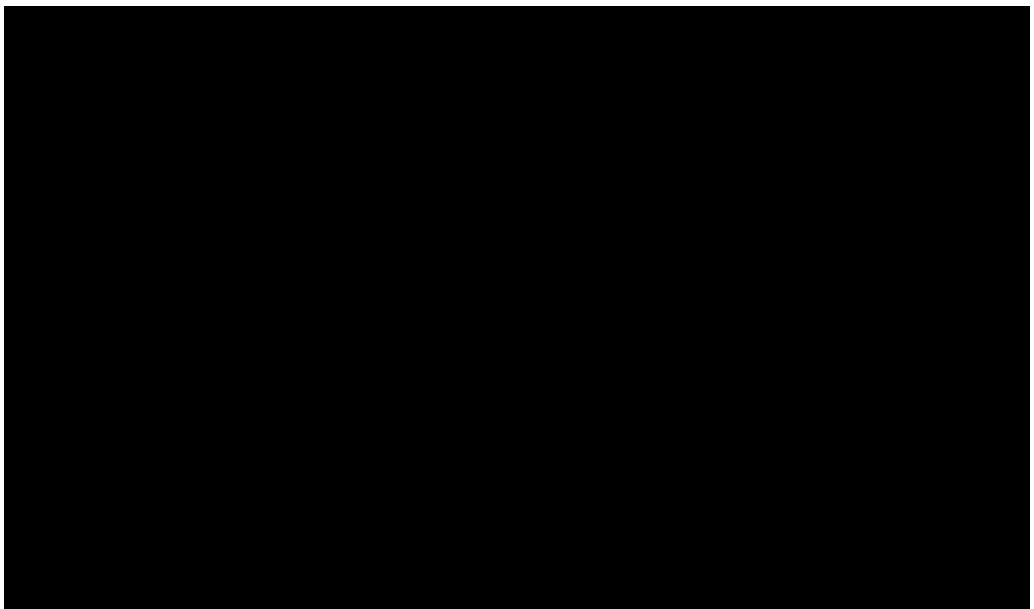
Table 3: Weight & Height

The following table shows the mean weight and mean height of patients in our study.

Parameter	Cases	
	Mean	S.D.
Weight (kgs)	58.4	10.4
Height (cms)	159.3	12.3

Figure 2

SEX DISTRIBUTION OF PATIENTS IN OUR STUDY



B. Anthropometric Indices:

Table 4: BMI of patients in our study.

The following table shows the percentage of patients with abnormal BMI.

Parameter	Cases	
	Mean	S.D.

Weight kgs	58.4	10.4
Height cms	159.3	12.3

The cut off value of body mass index above which it was taken as abnormal in our study was > 25. The mean BMI in our study group was 23.7. It was clearly made out from the table that nearly 70% of the study group has normal BMI. This is similar to the pattern seen among Asians, where the BMI was less but cardiometabolic risks are high.

Table 5: Waist Circumference

This table shows the number of patients with abnormal waist circumference in our study group.

Waist circumference (cms)	Cases	
	No	%

Normal [M≤ 90 & F ≤ 85]	97	71.9
Abnormal [M> 90 & F > 85]	38	28.1
Mean S.D.	86.1 cms 24.6 cms	

The mean waist circumference among the study group was 86 cms. Waist circumference was the best anthropometric index used in assessing cardiovascular risk factors in Asians as it measures truncal obesity and there by insulin resistance. In our patients, as in the general pattern for Asians, waist circumference was high inspite of having low BMI.

Table 6 : Waist/Height Ratio:

The following table shows the percentage of patients in our study group with abnormal Waist/Height ratio.

Waist/Height ratio	Cases	
	No	%

Normal (≤ 0.5)	66	48.9
Abnormal (> 0.5)	69	51.1
Mean S.D.	0.62 0.43	

It was found that nearly > 50% of patients in our study had higher Waist/Height ratio, but the BMI and waist circumference in these patients are low.

Height is an independent negative predictor of cardiovascular disease. The average height of the Asian was low when compared to western population. The waist circumference is also low among our population. But the cardiometabolic risk was high. So waist circumference /height ratio was taken and its significance was assessed.

C. Cardiac Risk Factors

Table 7: Fasting Blood Sugar

The following table shows percentage of patients with abnormal fasting plasma glucose i.e ≥ 110 mg/dl.

Fasting Blood Sugar	Cases	
	No	%
Normal (≤ 110 mg/dl)	109	80.7
At Risk (> 110 mg/dl)	26	19.3
Mean S.D.	98 37.1	

The mean fasting plasma glucose among the study group was 98 mg/dl. Fasting plasma glucose was the most widely accepted tool in the diagnosis of diabetes as recommended by the American diabetes Association. It was also easy and convenient for the patient, not waiting for two hours after breakfast as in postprandial blood glucose. But the major advantage with post prandial blood glucose was it was the first to become abnormal in early stage of diabetes. The cut-off value for fasting plasma glucose in our study was ≥ 110 mg/dl, because this was the cut off used in WHO criteria for metabolic syndrome.

The following table shows the percentage of patients with past history of any of the cardiovascular risk factors like Type 2 DM, systemic hypertension and dyslipidemia.

Table 8: Patients Known past history of Type 2 DM, Systemic Hypertension or Dyslipidemia

Known past history	Cases	
	No	%
Yes	44	32.6
No	91	67.4

This history was taken because patients fasting, BP, Lipid levels may be normal during the study due to treatment. In our study, only 32.6 % of patients had past history of either diabetes, hypertension or dyslipidemia. 67.4 % had no above mentioned risk factors.

The following table shows percentage of patients in our study group with abnormal blood pressure **.**

Table 9: Blood Pressure Pattern in our patients

.

Blood Pressure (mm Hg)	Cases	
	No	**%**
Normal (≤ 140/90)	82	61.2
At Risk (> 140/90)	53	38.8
Systolic B.P. Mean S.D. Diastolic B.P. Mean S.D.	132.9 21.4 83.8 11.1	

The cut off for abnormal BP in our study was ≥ 140/90 mm Hg because this was the cut off used in WHO criteria JNC 7 guidelines for diagnosis of systemic hypertension. In our study 38.8 % of patients had systemic hypertension.

The following table shows the percentage of patients with abnormal total cholesterol in our study group.

Table 10: Total Cholesterol

Total Cholesterol	Cases	
	No	%
Normal (≤ 220 mg/ dl)	107	79.3
At Risk (> 220 mg/ dl)	28	20.7
Mean S.D.	179.7 mg/dl 50.1 mg/dl	

The cut off value above which total cholesterol was considered abnormal in our study was ≥ 220 mg/dl. As per evidence, the pattern of dyslipidemia in asians shows that the total cholesterol levels are usually normal. In our study only 20% of patients had abnormal total cholesterol levels. So our study reflects the same pattern as seen in asians.

Table 11: TGL

The following table shows percentage of patients with abnormal triglyceride levels among the study group.

TGL	Cases	
	No	%

Normal (≤ 150 mg/ dl)	74	54.8
At Risk (> 150 mg/ dl)	61	45.2
Mean S.D.	156 mg/dl 63.3 mg/dl	

The mean TGL level among the study group was 156 ± 63.3 mg/dl.

Table 12: HDL

The following table shows percentage of patients with abnormal HDL levels among our study group.

HDL	Cases	
	No	%
Normal (≥ 40 mg/ dl)	87	64.4
At Risk (< 40 mg/ dl)	48	35.6
Mean S.D.	40.5 mg/dl 7.8 mg/dl	

The pattern of lipid among asian population was high triglyceride and low HDL levels. The total cholesterol and LDL levels are not that much high when compared to western population[17].

The following table summarises the previous tabulations, shows % of patients with abnormal fasting plasma glucose, BP etc.

Table 13: Abstract of Cardiac Risk Factors

Risk Factor	Cases	
	No	%
1. Abnormal Blood Sugar (F) (> 110 mg/dl)	26	19.3
2. Past known history (taking treatment)	44	32.6
3. Blood Pressure (> 140/90 mm Hg)	52	38.8
4.Total Cholesterol (> 220 mg/dl)	28	20.7
5. TGL (> 150 mg/dl)	61	45.2
6. HDL (< 40 mg/dl)	48	35.6
7. Any one of the above factors present	114	84.4

Finally it shows the % of patients with any of the above cardiac risk factors among our study group(Figure 3). Nearly 85% of patients in our study group had at least one of the above cardiovascular risk factors. Only 34.6 % of patients had previous history of risk factors. Our study was also useful in detecting risk factors in rest of the patients.

Figure 3

CARDIAC RISK FACTORS AMONG PATIENTS IN OUR SYUDY

D. Relationship Between Profile of Cases and Cardiac Risk Factors

The following table shows the Co-relation between the patient age and cardiovascular risk factors among our study group.

Table 14: Age and Cardiac risk factor

Cardiac risk	Age in years	
	Mean	**S.D.**
Present (114)	51.5 years	10.8 years
Absent (21)	46.8 years	14.8 years
'p'	0.0569 Not Significant	

It was found that there is no statistically significant association was found between the age and cardiac risk factors. P value = 0.0569.

The following table delineates the relationship between sex and cardiovasuclar risk factors.

Table 15: Sex and Cardiac risk factor

Sex	**Sex**			
	Males		**Females**	
	No	**%**	**No**	**%**
Present (114)	87	76.3	27	23.7
Absent (21)	21	100	-	-
'P'	0.0059 Significant			

It was found that the % of females with cardiovascular risk factors was found to be more in our study. The association between sex and cardiovascular risk factors was found to be statistically significant (P value 0.0059)(**Figure 4)**.

Figure 4

RELATIONSHIP BETWEEN SEX & CARDIAC RISK FACTORS

The following table shows relationship between waist circumference and cardiovascular risk factors among our study group.

Table 16: Waist circumference and Cardiac risk factor

Cardiac risk	Waist circumference					
	Normal		Abnormal		Mean	S.D.
	No.	%	No.	%		
Present (114)	78	68.4	36	31.6	87.4	24.5
Absent (21)	19	90.5	2	9.5	79	24.5
'p'	0.0082 Significant					

The percentage of patients in our study group with abnormal waist circumference associated with any one of the cardiovascular risk factors was 31.6% (**Figure** 5).The association between them was statistically significant (P value 0.0082).

Figure 5

RELATIONSHIP BETWEEN WAIST CIRCUMFERENCE &

CARDIAC RISK FACTORS

The following table shows co-relation of BMI with cardiovascular risk factors among our study group.

Table 17: BMI and Cardiac risk factor

Cardiac risk	BMI					
	Normal		Abnormal		Mean	S.D.
	No.	%	No.	%		
Present (114)	76	66.7	38	33.3	24.18	8.68
Absent (21)	19	90.5	2	9.5	20.89	3.09
'p'	0.0336 Significant					

It was found that nearly 33.3% of patients with abnormal BMI had any one of the cardiovascular risk factors(**Figure 6)**. The association between BMI and cardiovascular risk factors also statistically significant. (P value 0.0336).

Figure 6

RELATIONSHIP BETWEEN BMI & CARDIAC RISK FACTORS

The following table shows correlation between Waist / Height ratio and the Cardiovascular risk factors among our study group.

Table 18 : Waist / Height ratio and Cardiac risk factor

Cardiac risk	Waist / Height ratio					
	Normal		Abnormal		Mean	S.D.
	No.	%	No.	%		
Present (114)	51	44.7	63	55.3	0.56	0.21
Absent (21)	15	71.4	6	28.6	0.49	0.14
'p'	0.007 Significant					

It was found that 55.3% of the patients among our study group with abnormal waist/height ratio had any of the cardiovascular risk factors(**Figure 7**).

The association between waist/height ratio and cardiovascular risk factors was found to be statistically significant (P value 0.007). This was the prime aim of our study.

Figure 7

CO-RELATION BETWEEN WAIST/HEIGHT RATIO &

CARDIAC RISK FACTORS

The following table compares the efficacy of the anthropometric indices in identifying the cardiovascular risk factors and also compares their statistical significance.

Table 19: Efficacy of various parameters in predicting cardiac risk

Parameter	Cardiac risk (114 cases)			
	Present		Absent	
	No.	%	No.	%
a) Abnormal Waist	36	31.6	78	68.4
b) Abnormal BMI	38	33.3	76	66.7
c) Abnormal Waist/Height Ratio	63	55.3	51	44.7
'p' values between 'a' & 'c'	0.0005 Significant			
'p' values between 'b' & 'c'	0.0014 Significant			
'p' values between 'a' & 'b'	0.8875 Not Significant			

By comparison it was found that among our study group, waist/height ratio was found to be more effective in identifying cardiovascular risk factors than other indices like BMI and waist

circumference. Nearly 55.3% of patients with abnormal waist/height ratio had one or more of the cardiovascular risk factors(**Figure 8)**.

In our study the association between waist/height ratio and cardiovascular risk factors was found to be statistically significant. So the primary end point obtained from statistical analysis in our study was weight/ Height ratio was the more effective anthropometric index used in identifying cardiometabolic risk factors when compared to BMI and waist circumference.

Figure 8

PERCENTAGE OF PATIENTS IN OUR STUDY WITH

CARDIAC RISK FACTORS

DISCUSSION

DISCUSSION

Epidemiology:

All of the 135 patients taken for our study belong to low socioeconomic status group. These 135 patients were not representative of general population. Regarding their occupation most of them are cooly workers with high physical activity. In our study the cardio metabolic risk and use of anthropometric measures are studied in this population.

Previously it was thought that diabetes mellitus, systemic hypertension, coronary artery disease and dyslipidemia were urban diseases. But today it is not so. The prevalence and incidence of these cardio metabolic diseases is high in India and is increasing even though >60% of Indians belong to low social economic group and living in rural areas.

Among 135 patients taken in our study, 114 are males and 21 are females. Number of female patients taken in our study was low because many female patients where not willing to take part in our study. More

female patients should be studied to assess the anthropometric parameter usage in identifying cardio metabolic risk factors.

The drawbacks in our study regarding case selection are

1) Limited number of patients
2) Female patients are less in number
3) All Patients belong to low socioeconomic groups living in rural areas and so not representing the general population.

Cardiovascular risk factors:

The cardiovascular risk factors taken in our study are

a) Fasting plasma glucose
b) Blood pressure
c) Serum total cholesterol
d) Serum triglycerides
e) Serum HDL

Fasting Plasma Glucose:

In our study fasting plasma glucose was taken after 8 hours fasting. The cut off values for fasting plasma glucose used in our study is 110 mg/dl above which it is considered abnormal .This cut off value is taken

because this is the cut off value used in WHO criteria for metabolic syndrome and this is the same cut off used in the reference study done among Japanese people. The advantage of the fasting glucose is its reliability, convenience to the patients and the values are not altered by patient factors. The drawback of fasting plasma glucose is that it may be normal in early stages of diabetes[19].In such situations, post prandial plasma glucose is the ideal test.

Blood Pressure:

In our study, BP is taken 3 times over a period of 1 week. The cut off values for BP is ≥ 140/90 mm Hg in our study. This same cut off is used in WHO criteria for metabolic syndrome and JNC 7 guidelines for diagnosis of systemic hypertension. systemic hypertension is considered an important cardiovascular risk factor.

Dyslipidemia:

In our study fasting serum total cholesterol, triglyceride and HDL levels are taken. In asians the pattern of lipids is high triglycerides, with low HDL levels. In our study ,the mean total cholesterol is 180 mg/dl, mean triglyceride levels is 156 mg/dl and mean HDL levels is 40.5 mg/dl. Our study also reflects the same pattern of lipids among asians **(3)** . **Shiun**

Dong Hsieh et al.2005 [(1)] also found the same pattern of dyslipidemia in his study group.

Anthropometry:

The anthropometric indices taken in our study are

a) BMI

b) Waist circumference

c) Weight height ratio

Body Mass Index:

Generally asians have low BMI when compared to western population. But inspite of having low BMI in asians, the risk of cardio metabolic diseases are high. In our study also, the mean BMI was 23.5 on the lower level.

The mean BMI of patients in the study conducted by **Shiun Dong Hsieh et al.2005** [(1)] on Japanese population also showed a similarly low value.

Body mass index does not reflect the total fat mass, and also the fat distribution. It is found out that truncal obesity (both the subcutaneous and visceral fat) are responsible for insulin resistance. Insulin resistance is the key factor in cardio metabolic diseases as shown in many studies[20]. BMI is not a good parameter to assess truncal obesity and insulin resistance.

In asians the incidence of visceral obesity is high, but the BMI is low. In our study the correlation of BMI with cardio metabolic risk factors is only 33.3%, but their association is statistically significant (P value 0.0336). So according to our results, BMI was found to be less effective in identifying cardiovascular risk factors. **Shiun Dong Hsieh et al.2005 [(1)]** in their study done among Japanese population also had the same results regarding BMI.

The BMI cut off used in our study is >25 kg/m^2 standard value for all population. But a lower cut off for BMI may be required in identifying cardiovascular risks in Asians.

Waist Circumference:

Waist circumference taken in our study is measured at the level of mid point between lower costal margin and iliac crest. Till now it is used as a better anthropometric index used in assessing truncal obesity.

The major pit falls of waist circumference are

1) There is no international standard value for all population. It varies among various ethnic groups.
2) Different cut off values used for both sex.
3) Height, a negative independent risk factor for cardiovascular disease is not taken into account. Cardiovascular Risk associated with high waist circumference varies with height in the same individual.

The cut off values taken for waist circumference in our study was males > 90cms and females > 85cms as per asian standards. So the cut off values for waist circumference taken in our study correlates with our Indian standards.

In our study nearly 31.6% of patients with abnormal waist circumference has cardiovascular risks. This association is low , but it was found to be statistically significant in our study (P values 0.0082) as found in the study conducted by **Shiun Dong Hsieh et al.2005 [(1)].**

Waist/Height ratio:

Still now effective anthropometric parameter to assess truncal obesity and insulin resistance with standard cut off values for all sex and ethnic group is not available[21]. So the prime aim of our study is to search for a new effective, standard and cheap anthropometric index (i.e Waist/Height ratio) in identifying cardio metabolic risk factors.

Waist/Height ratio is the newer parameter taken in our study, its effectiveness is studied and compared with other parameters like BMI and waist circumference. The reference for this study was taken from the Journal of preventive medicine published in July 2005(**Shiun Dong Hsieh et al.2005 [(1)])**. This study was done in Japanese population with 4,668 men and 1,853 women. The cut off for Waist/Height ratio used in the study was > 0.5 which was also the same cut off used in our study. It means that if waist circumference is more than half of the vertical height, the individual is at risk of cardiovascular disease[22].

In our study nearly 55.3% of patients with abnormal Waist/Height ratio had cardiovascular risk. The association between Waist/Height ratio and cardiovascular risk factors was also found to be statistically much significant, the P value was 0.0005. But by comparison only 33.3% and 31.6% of patients with abnormal BMI and waist circumference had cardiovascular risk.

In the large reference study among Japanese population (**Shiun Dong Hsieh et al.2005 [(1)]**) it was found that Waist/Height ratio was the

superior parameter to evaluate clustering of coronary risk factors than BMI and waist circumference. In our study also Waist/Height ratio is the superior parameter. No Indian studies are yet available on Waist/Height ratio. Our study may act as a preliminary study among Indian population.

Advantages of Weight/Height ratio found as per our study.

1) Standard cut off values for both sexes and all ethnic groups and different ages.
2) Height , an independent negative risk factor for cardiovascular disease is also taken into account. Moreover, waist circumference should be viewed in context with height because individuals with same waist circumference with varying height have different cardiovascular risks.
3) More accurate tracking of fat distribution and accumulation by age.
4) Close correlation with cardio metabolic risk factors.

5) More comprehensive identification of overweight individuals and those of normal weight and BMI facing higher cardiovascular risks.

6) Higher sensitivity and more balanced sensitivity and specificity for an index of Waist/Height ratio > 0.5 for identifying higher risk people.

7) Greater simplicity.

Waist circumference is a popular anthropometric index for measurement of central fat distribution and weight management **(WHO 2000)**. However the suggested boundary value of waist circumference varies by gender and ethnicity[23]. Height in contrast is an important factor that should be considered before adopting such an index because height may confound observation of fat accumulation and/or distribution. If we intend to use a single index of waist circumferences for health educational purposes, then shouldn't we clarify that people with similar waist circumferences share similar health risks irrespective of height?. The data and the inverse correlation seen between height and age in cross sectional studies in asians were attributed to the fact the early nutritional environment of asians differ dramatically in different generations. On the other hand, Weight/Height values showed fewer sex based differences

than those for waist circumference and even BMI at various age intervals. Thus, using a height adjustment for waist circumference might better reflect the relative fat distribution of asian Individuals. There are also a number of reports concerning the inverse and independent effect of the risk factors of cardiovascular disease. Infact the use of a single index of waist circumference for all individuals may lead to an over estimation of risk in tall people and under estimation of risk in short people[24].

In our study by comparison it was found that Waist / Height values is the superior and effective parameter in identifying cardio metabolic risk in both sexes. Till now only few studies are available on this. No Indian study is yet available, so our study provides a preliminary evidence that Waist/Height values may be a superior and effective anthropometric index[25].

According to our study **"Keep your Waist Circumference below half of your Height"** may be a simple and effective public health message for the prevention of metabolic syndrome.

More Indian studies done among larger and different populations are required to confirm this observation.

CONCLUSION

CONCLUSION

As per our study

a) Waist/Height ratio with cut off > 0.5 is found to be an effective, newer and cheaper anthropometric index in identifying cardiovascular disease.

b) Waist/Height ratio with cut off > 0.5 is a effective parameter in all ages and both sexes among Indians.

c) Waist/Height ratio with cutoff > 0.5 is the superior parameter in identifying cardiovascular disease than BMI and waist circumference.

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Shiun Dong Hsieh MD Takashi Moto MD et al.The superiority of Waist/ Height ratio to evaluate coronary risk factors .Preventive Medicine.2005.(40).216-220
2. RSSDI Text book of Diabetes 2003.
3. Joslin Text book of Diabetes.13th Edition.2005

4. William and John Pickup Text book of Diabetes.Third Edition.2003.
5. Hsieh,Yoshinaga H,Muto T Sakurai. Anthropometric Obesity indices in relation to age and gender in Japanese adults.Tohoku J.Exp Med 2000.
6. Lee J S et al.A study on indices of body fat distribution for screening of obesity.1995
7. Albert.G.Introduction to metabolic syndrome.EHJ 2005:7
8. API Text book of Medicine.8th Edition
9. Harrisons Principles of Internal Medicine.16th Edition
10. Enas Enas & Annamalai Senthilkumar.Coronary Artery Disease in Asian Indians.An update and Review.The internet journal of cardiology.2001;(1).
11. Kevin P.Devid T et al.Years of life lost due to obesity.JAMA 2003.
12. Milan Guptaet al.South Asians and cardiovascular Risk: What clinician should know circulation.2006;113;e924-e929.
13. Hubbard VS : Defining overweight and adiposity what are the issues.Am.J.Clin.Nutr.2000;72:1067-8
14. Kumar and ClarkesText book of Internal Medicine,sixth edition.
15. Macleod's clinical examination- Eleventh edition
16. Braunwald's Heart Disease,7th edition,

17. Ramachandran A,Kapur et al.High prevalence of Diabetes and impaired glucose tolerance in India.National Urban Diabetes Survey. Diabetologic 2001;44:1094-101-
18. Acartek E et al.Relation between age and gender differences in plasma triglyceride concentrations and CAD in southern Turkey.clin clim acts,2004 jan,33-9:123-8.
19. Despres JP et al. Treament of Obesity:Need to focus on high risk abdominally obese patients.
20. Sonmez et al.Which method should be used to determine the obesity in patients with CAD(BMI,waist circumference).Int J Obes Metab Discord 2003;27(3):341 (6)
21. TS Hans et al.Waist circumference action levels in identification of cardiovascular risk factors.BMJ.1995:311:1401-5.
22. Likim AS et al; Relationship between cardiovascular risk indicators and types of obesity in overweight and obese persons.J Int Med Res.2004:32 (3):268-73.
23. Balkau B et al.Presreening tools for Diabetes and Obesity associated dyslipidemia:Comparing BMI and Waist circumference. The D.E.S.I.R study 1 Eur I Clin Nutr.2006.60 (3):298-304.
24. Current Medical Diagnosis and Treatment.2008.

25. www.diabetes.com; Redefining Obesity and its treatment –the Asia Pacific perspective 2000:International Diabetes Institute in Australia and WHO .
26. Dudeja Vet et al;BMI does not accurately predict overweight in Asian Indians in Northern India.Br J Nutr 2001;86:105-112.
27. Superho,HR et al.1985 Am.J Med 78:826.
28. Johnson JL et al.Gender and racial differences in lipoprotein subclass distribution.The STRRIDE study,Atherosclerosis 2004,176 (2)371-7.
29. Rajeev Gupta et al. Lipid abnormalities in coronary heart disease.A population based case control study.Indian Heart J.2001;53:332-336.
30. Gupta R et al.Educational status coronary heart disease and coronary risk facto prevalence in rural population of India.BMJ:1994;309:1332-1336.

APPENDIX -I
PROFORMA

APPENDIX I – PROFORMA

USE OF WAIST HEIGHT RATIO IN IDENTIFYING CARDIOVASCULAR RISK FACTORS

Name:

Age

Sex

Past History: DM / HTN / Dyslipidemia

Anthropometry

Height

Weight

Waist Circumference

BMI

Waist Height Ratio

GENERAL EXAMINATION

BP

INVESTIGATIONS

Fasting Plasma Glucose

Fasting Serum Total Cholesterol

Fasting Serum HDL

Fasting Serum Triglcerides

APPENDIX II – MASTER CHART

MASTER CHART

Sl.No	NAME	WEIGHT	HEIGHT	BMI	WAIST	W/H	PG(F)	SYS.BP	DIABP	TC	TGL	HDL	PAST HISTORY	ABNOR
1	Nagaraj, 52/M	55	164.5	20.33	75	0.46	92	130	80	177	103	34	2	2
2	Narayanan, 60/M	55.5	164	20.64	86	0.52	86	140	90	163	99	39.7	2	2
3	Manickam, 60/M	54	159.5	21.23	79	0.50	110	150	90	190	302	39.7	2	2
4	Arjunan, 60/M	68	168	24.09	97	0.58	86	120	80	210	194	40.8	2	2
5	Meenakshisundaram 50/M	65	169.5	22.62	90	0.53	86	130	80	161	123	29.1	2	2
6	Bose 60/M	70	168	24.80	90	0.54	80	120	80	307	140	59	2	2
7	Lakshmi 55/F	75	150	33.33	110	0.73	89	130	90	188	175	45.1	2	2
8	Panchavarnam 46/F	70	154	29.52	92	0.60	90	140	90	214	175	35	1	2
9	Panchachalam 60/M	55	157.5	22.17	88	0.56	85	130	100	160	122	34.7	1	2
10	Suseela 60/F	65	154.5	27.23	90	0.58	65	130	90	223	345	38.9	2	2
11	Lakshmi 60/F	55	141	27.66	86	0.61	66	130	90	187	159	47.6	2	2
12	Nagoor 40/M	81	168	28.70	100	0.60	92	180	90	178	204	31.8	2	2
13	Gurusamy 55/M	54	163	20.32	82	0.50	85	130	80	181	80	48.2	2	2
14	Packialakshmi 58/F	64	154	26.99	84	0.55	80	130	90	192	104	70.9	2	2
15	Arunagiri /M	65	172	21.97	92	0.53	82	150	90	233	126	40.6	1	2
16	Jeyalakshmi 47/M	60	165	22.04	79	0.48	89	160	90	113	100	25.5	2	2
17	Lakshmi 55/F	49	174	16.18	66	0.38	72	170	100	79	102	25.5	2	2
18	Boopathy 60/M	49	164	18.22	74	0.45	82	138	90	247	153	50.4	2	2
19	Thangamani 43/M	54	160	21.09	74	0.46	65	140	90	169	122	31.3	2	2
20	Rajathi 51/F	56	145	26.63	88	0.61	70	140	90	181	122	48.2	1	2
21	Challammal 62/F	52	144	25.08	72	0.50	65	150	100	218	143	49	1	2
22	Subedha 63/F	63	154	26.56	84	0.55	92	130	80	214	196	64.1	2	2
23	Manickam 85/M	69	159	27.29	82	0.52	100	160	100	219	193	56.3	2	2
24	Vijaya 54/F	60	153	25.63	87	0.57	89	140	100	187	130	42.3	2	2
25	Manimegalai 60/F	55	147	25.45	80	0.54	86	150	110	279	379	54.7	1	2
26	Thirupathi 55/M	54	145	25.68	80	0.55	91	200	110	169	181	39.4	2	2
27	Mumtaj 50/F	66	147	30.54	87	0.59	130	130	90	273	355	44.4	2	2
28	Chellathai 60/F	55	149	24.77	96	0.64	72	150	100	260	200	40	1	2
29	Amaidi 53/F	70	155	29.14	96	0.62	98	150	100	254	118	58.4	2	2
30	Kesavan 32/M	57	153	24.35	77	0.50	96	180	110	177	135	35	1	2
31	Dhanam 57.F	66	155	27.47	64	0.41	65	140	90	187	159	32	1	2
32	Mary 65/F	58	144	27.97	98	0.68	70	150	100	215	88	52.8	2	2
33	Pandiammal 51/F	56	162	21.34	88	0.54	90	150	90	221	226	41.6	2	2
34	Gandhi 55/M	50	142	24.80	75	0.53	84	150	90	270	176	50.6	2	2
35	Alagammal 45/F	73	153	31.18	90	0.59	90	140	80	147	100	42.3	2	2
36	Pandiammal 43/F	75	162	28.58	95	0.59	89	150	100	255	213	35	2	2
37	Ravichandran 50/M	64	164	23.80	86	0.52	99	170	100	232	187	31	1	2

Sl.No	NAME	WEIGHT	HEIGHT	BMI	WAIST	W/H	PG(F)	SYS.BP	DIABP	TC	TGL	HDL	PAST HISTORY	ABNOR
38	Ganesan 40/M	49	163	18.44	60	0.37	100	140	90	190	110	41	2	2
39	Sony 35/M	77	177	24.58	93	0.53	90	130	80	210	168	36	1	2
40	Uma 52/F	66	143	32.28	92	0.64	90	130	80	240	110	35	1	2
41	Suruliraj 59/M	65	152	28.13	104	0.68	88	140	100	210	140	36	1	2
42	Jeyaram 55/M	70	156	28.76	86	0.55	79	150	80	180	145	40	1	2
43	Sonai 56/M	50	160	19.53	81	0.51	92	130	70	170	110	40	1	2
44	Chinnapan 57/M	45	160	17.58	81	0.51	138	140	90	220	200	35	1	2
45	Mani 37/M	55	168	19.49	82	0.49	84	150	80	240	235	39	1	2
46	Dharman 53/M	50	165	18.37	80	0.48	95	130	70	150	120	42	1	1
47	Muthukrishnan 45/M	70	164	26.03	90	0.55	73	140	80	140	110	40	1	1
48	Muthu 52/M	57	152	24.67	92	0.61	83	160	100	190	144	41	1	2
49	Kalliappan 60/M	55	162	20.96	82	0.51	91	130	70	140	120	45	1	1
50	Virumandi 62/M	60	162	22.86	88	0.54	150	150	70	220	95	39	1	2
51	Dhanushkodi 47/M	62	174	20.48	88	0.51	140	140	100	170	120	40	1	2
52	Chinnasamy 46/M	35	152	15.15	68	0.45	80	130	70	140	90	42	1	1
53	Syed Moideen 49/M	45	150	20.00	66	0.44	93	120	80	120	95	40	1	1
54	John 35/M	54	152	23.37	70	0.46	85	120	90	130	86	42	1	1
55	Ramasamy 77/M	60	154	25.30	80	0.52	97	110	70	140	110	40	1	1
56	Alagar 40/M	68	160	26.56	85	0.53	86	180	90	140	135	45	1	2
57	Matchakalai 50/M	45	152	19.48	66	0.43	130	120	80	210	135	39	1	2
58	Navaneethan 40/M	62	157	25.15	81	0.52	125	110	70	300	109	42	1	2
59	Murugan 37/M	56	161	21.60	76	0.47	65	130	80	250	109	40	1	2
60	Mayalagan 65/M	52	160	20.31	71	0.44	84	110	70	130	215	42	1	2
61	Arumugan 25/M	47	157	19.07	60	0.38	78	130	80	181	220	41	1	2
62	Kannan 42/M	56	163	21.08	75	0.46	85	140	80	168	134	42	1	1
63	Sahul Hameed 46/M	67	173	22.39	90	0.52	179	140	90	168	290	42	2	2
64	Kannadasamy 65/M	62	163	23.34	75	0.46	175	106	80	120	215	40	2	2
65	Rajendran 38/M	66	158	26.44	84	0.53	125	130	80	122	144	42	1	2
66	Ravichandran 42/M	58	162	22.10	78	0.48	69	110	80	139	158	44	1	2
67	Alagar 41/M	89	164	33.09	110	0.67	78	120	80	258	210	35	1	2
68	Sabarivasan 23/M	58	160	22.66	68	0.43	80	126	90	140	138	44	1	1
69	Seenivasan 44/M	60	164	22.31	80	0.49	98	130	90	268	200	42	1	2
70	Alagar 37/M	58	160	22.66	60	0.38	80	130	80	179	218	40	1	2
71	Namasivayam 45/M	68	162	25.91	104	0.64	132	140	90	230	206	40	1	2
72	Kamal 72/M	48	161	18.52	70	0.43	87	100	70	130	198	40	1	2
73	Ayyavoo 65/M	69	153	29.48	88	0.58	91	130	80	201	207	42	1	2
74	Baskaran 45/M	50	155	20.81	72	0.46	61	100	70	130	212	40	1	2

Sl.No	NAME	WEIGHT	HEIGHT	BMI	WAIST	W/H	PG(F)	SYS.BP	DIABP	TC	TGL	HDL	PAST HISTORY	ABNOR
75	Gurunathan 60/M	68	167	24.38	84	0.50	94	130	80	198	129	40	1	1
76	Paramasivam 56/M	55	163	20.70	79	0.48	186	100	70	161	116	42	1	2
77	Kamarajan 26/M	52	162	19.81	72	0.44	95	110	70	145	211	40	1	2
78	Thangamuniyandi 52/M	54	153	23.07	80	0.52	120	110	70	110	115	37	2	2
79	Gothandaraman 64/M	58	165	21.30	78	0.47	69	140	90	129	201	46	2	2
80	Kamatchi 65/M	52	152	22.51	71	0.47	60	130	70	122	203	44	1	2
81	Ramanathan 43/M	60	162	22.86	70	0.43	88	100	70	128	98	42	1	1
82	Arumugam 48/M	52	154	21.93	80	0.52	90	124	82	208	106	40	1	1
83	Malayandi 80/M	49	161	18.90	61	0.38	84	110	90	124	104	45	1	1
84	Muthupandiyan 55/M	60	164	22.31	86	0.52	88	100	70	240	190	36	1	2
85	Sakthivel 52/M	48	158	19.23	63	0.40	68	110	80	182	108	41	2	2
86	Sethumaran 65/M	56	168	19.84	66	0.39	84	140	80	188	220	38	1	2
87	Jeyaraman 40/M	55	166	19.96	70	0.42	108	130	80	194	168	43	1	2
88	Karuthakannan 55/M	55	170	19.03	78	0.46	120	110	70	182	206	43	1	2
89	Subbaya 50/M	68	158	27.24	68	0.43	98	150	100	240	190	46	1	2
90	Srinivasan 52/M	62	158	24.84	86	0.54	82	130	80	180	208	43	1	2
91	Suthiya 52/M	70	165	25.71	89	0.54	118	140	90	146	198	43	1	2
92	Duraisamy 80/M	61	158	24.44	68	0.43	81	130	70	160	185	32	1	2
93	Mokkan 60/M	65	161	25.08	70	0.43	94	110	70	168	148	32	1	2
94	Subramaniyan 65/M	75	169	26.26	78	0.46	137	100	70	110	217	35	2	2
95	Kumarandi 50/M	65	162	24.77	70	0.43	120	120	80	196	240	32	1	2
96	Balaguru 55/M	52	160	20.31	74	0.46	98	140	90	142	104	40	1	2
97	Pandi 58/M	49	163	18.44	68	0.42	69	100	80	170	110	42	1	1
98	Perumal Devar 41/M	51	158	20.43	69	0.44	143	170	100	123	100	43	1	2
99	Karuppaiya 35/M	62	165	22.77	80	0.48	85	100	70	170	126	44	1	1
100	Chandrasekar 32/M	51	165	18.73	68	0.41	63	110	80	130	124	42	1	1
101	Balan 40/M	53	159	20.96	65	0.41	84	120	70	123	134	42	1	1
102	Selvan 35/M	56	164	20.82	70	0.43	60	130	80	154	154	42	1	2
103	Ganesan 60/M	59	162	22.48	82	0.51	61	110	70	120	173	50	1	2
104	Kali 50/M	52	158	20.83	69	0.44	128	140	80	200	79	44	2	2
105	Muthusamy 58/M	68	167	24.38	96	0.57	88	130	90	176	155	40	1	2
106	Jeyakumar 45/M	55	167	19.72	70	0.42	108	180	80	140	168	38	1	2
107	Karuppusamy 55/M	54	163	20.32	78	0.48	108	150	80	240	99	42	2	2
108	Mari 54/M	48	162	18.29	68	0.42	69	100	80	130	80	40	1	1
109	Senthil 35/M	80	166	29.03	101	0.61	91	110	70	183	247	29.4	1	2
110	Pandi 48/M	63	160	24.61	97	0.61	89	110	80	120	125	23.2	1	2
111	Irulandi 65/M	82	175	26.78	99	0.57	90	190	100	143	122	33.7	1	2

Sl.No	NAME	WEIGHT	HEIGHT	BMI	WAIST	W/H	PG(F)	SYS.BP	DIABP	TC	TGL	HDL	PAST HISTORY	ABNOR
112	Velusamy 73/M	84	160	32.81	93	0.58	75	140	90	133	205	22.1	1	2
113	Murugan 43/M	53	164	19.71	72	0.44	82	170	100	121	72	20.4	1	2
114	Prakash 23/M	48	180	14.81	61	0.34	94	110	80	180	90	40	1	1
115	Murugan 40/M	67	165	24.61	96	0.58	100	130	80	200	100	42	1	1
116	Karunanidhi 58/M	45	168	15.94	156	0.93	104	130	80	71	189	48	1	2
117	Mahamani 54/M	45	183	13.44	157	0.86	86	120	80	207	254	49	1	2
118	Thanthi 60/M	40	159	15.82	157	0.99	130	100	70	100	142	25.2	2	2
119	Muthiah 40/M	54	168	19.13	178	1.06	110	100	70	136	55	71.2	1	1
120	Baskaran 38/M	65	185	18.99	160	0.86	140	110	80	300	160	30	2	2
121	Mohan 36/M	66	175	21.55	181	1.03	86	110	70	144	76	29.1	1	2
122	Manimegalai 45/F	75	102	72.09	162	1.59	95	130	80	90	180	40	1	2
123	Prema 45/F	64	93	74.00	161	1.73	74	128	80	170	102	39	1	2
124	Samuthiram 46/M	50	178	15.78	154	0.87	91	110	80	120	214	40	1	2
125	Murugesan 55/M	68	104	62.87	162	1.56	132	140	90	130	198	40	2	2
126	Sheik Masthu 65/M	43	160	16.80	70	0.44	104	160	100	169	60	40	2	2
127	Anandham 60/M	47	164	17.47	66	0.40	68	150	70	104	74	42	2	2
128	Karuppiah 52/M	53	162	20.20	77	0.48	103	180	70	112	98	30	2	2
129	Sampath 45/M	53	170	18.34	76	0.45	112	150	110	254	173	35	2	2
130	Chandramohan 32/M	74	180	22.84	90	0.50	67	150	90	240	421	39	1	2
131	Raju 45M	51	168	18.07	74	0.44	356	110	70	157	145	36	2	2
132	Ramuthai 36/F	27	148	12.33	48	0.32	195	110	70	201	105	38	1	2
133	Murugavalli 35/F	30	142	14.88	66	0.46	96	110	70	278	117	40	1	2
134	Ponnuthai 50/F	47	161	18.13	72	0.45	279	110	70	243	80	37	1	2
135	Kaliyammal 34/F	39	148	17.80	81	0.55	120	170	110	231	97	35	1	2

ABBREVIATIONS AND ACRONYMS

ABBREVIATIONS AND ACRONYMS

- HTN – Hypertension
- DM – Diabetes Mellitus
- CVD – Cardiovascular Disease
- BMI – Body Mass Index
- LDL – Low Density Lipoprotein
- HDL - High Density Lipoprotein
- WC – Waist Circumference
- TGL – Triglycerides
- CAD – Coronary Artery Disease
- TNF – Tumor Necrosis Factor